

U.S.S.N. 10/038,800

REMARKS

Thorough examination and careful review of the application by the Examiner is noted and appreciated.

Claims 1-15 are pending in the application. Claims 1-15 stand rejected.

Objection To The Claims

Claim 12 is objected to as being of improper dependent form for failing to further limit the subject matter of a previous claim.

Claim 12 has been amended to correct a typographical error by further reciting that the insulating material layer is deposited in silicon oxide. This is supported by the specification on page 10, lines 17-18.

Claim Rejections Under 35 USC §103

Claims 1-6 and 8 are rejected under 35 USC §103(a) as being unpatentable over Shields '646 publication in view of Suzuki '459.

U.S.S.N. 10/038,800

The rejection of claims 1-6 and 8 under 35 USC §103(a) based on Shields and Suzuki is respectfully traversed.

Shields discloses a silicon oxynitride anti-reflective coating for metal patterning in which a silicon oxynitride ARC/hard mask is formed on a metal layer and patterned, avoiding a separate hard mask. In the Shields' process, a **thin** silicon oxide layer is formed on top of the silicon oxynitride layer in order to improve resistance to footing. As stated at page 3, left column, lines 6-8:

"Silicon oxide layer 36 can be formed at a thickness of about 20 angstrom to about 300 angstrom without significantly increase the height of the stack".

The Applicants respectfully submit that Shields teaches a completely different process of forming metal lines when compared to the present invention process of forming a deep via with large aspect ratio in a silicon oxide layer. For instance, at page 14 of the specification, lines 15+:

"As shown in Figure 3, the depth of the via openings 40, shown as "L₂" is measured to be 639 nm, which represents a 40% improvement over that obtained by the conventional method shown in Figure 2".

The thickness of the silicon oxide layer, into which the deep via opening is formed, is therefore at least 6400 angstrom, when compared to the silicon oxide layer of Shields at 20-300 angstroms. Shields therefore does not teach the present invention process of forming a deep via with high aspect ratios. The Applicants further submit that whether Suzuki teaches curing a photoresist with UV radiation, Suzuki does not lend any additional weight in a §103 rejection of claims 1-6 and 8 since the basic deep via forming process is not taught by either Shields or Suzuki, either singularly or in combination thereof.

The rejection of claims 1-6 and 8 under 35 USC §103(a) based on Shields and Suzuki is respectfully traversed. A reconsideration for allowance of these claims is respectfully requested of the Examiner.

Claim 7 is rejected under 35 USC §103(a) as being unpatentable over Shields, Suzuki and further in view of Hsia '724. It is contended that Hsia teaches that in a conventional metallization process, it is known that a chemical compound film will be formed on the metal layer during the etching process as a result of a reaction between the hydrocarbon polymers of the photoresist and the chlorine or fluorine molecules contained in the reactive ion etching chemicals.

The rejection of claim 7 under 35 USC §103(a) based on Shields, Suzuki and Hsia is respectfully traversed.

Claim 7 depends on independent claim 1, which the Applicants have clearly shown is not taught by the two primary references of Shields and Suzuki. The Applicants further submit that the additional reference of Hsia does not lend any additional weight in a §103 rejection, since Hsia does not teach the forming of a deep via with high aspect ratios.

U.S.S.N. 10/038,800

The rejection of claim 7 under 35 USC §103(a) based on Shields, Suzuki and Hsia is respectfully traversed. A reconsideration for allowance of these claims is respectfully requested of the Examiner.

Claims 9-15 are rejected under 35 USC §103(a) as being unpatentable over Shields in view of Jain '456. The Examiner contended that while Shields is silent on the exposure process of the DUV photoresist and does not disclose that the DUV photoresist is irradiated with UV radiation for at least 1 minute, such is taught by Jain that for a typical lamp in a typical DUV exposure system, the exposure time for photoresist sensitive in the DUV range, is usually several minutes.

The rejection of claims 9-15 under 35 USC §103(a) based on Shields and Jain is respectfully traversed.

Jain discloses a method for transforming a light beam into a line source of required curvature and finite numerical aperture. The process time for UV exposure referred to by Jain, contained in col. 1, lines 29-33:

"For a typical lamp in a typical system, the total deep UV power then can be collected for use is in the few tens of milliwatts range, so that the exposure time for photoresists that are sensitive in the deep UV are typically several minutes."

The Applicant respectfully submit that the present invention process does not claim an exposure time for exposing a deep UV photoresist for at least 1 minute. To the contrary, the present invention UV curing process is a step performed before the photoresist exposure process. This is clearly recited in claim 9:

"... forming a deep UV photoresist layer on top of said insulating material layer;
irradiating said deep UV photoresist layer with UV radiation for at least 1 minute;
defining an opening for a hole;
etching said hole having an aspect ratio of larger than 8 in said insulating material ..."

The present invention process is further presented in the specification at page 14, line 8+:

U.S.S.N. 10/038,800

"The deep UV photoresist layer 46 is then cured by UV radiation at a temperature of at least 100°C, and preferably 160°C for a time period between about 1 min and about 10 min, and preferably between about 2 min and about 4 min. The deep UV photoresist layer 46 is thus stabilized by the curing process and the reaction of carbon from the resist material in forming fluorocarbon polymers with fluorine from the etchant gas is thus greatly reduced".

Furthermore, at page 15, lines 1-5:

"The present invention novel method for forming via openings or contact holes with improved aspect ratios by using deep UV photoresist layers and **pre-curing the layers prior to patterning** has therefore been amply described in the above descriptions and in the appended drawing of Figure 3".

The Applicants therefore respectfully submit that Jain does not teach the present invention UV pre-curing process prior to a photoresist exposure process.

U.S.S.N. 10/038,800

The rejection of claims 9-15 under 35 USC §103(a) based on Shields and Jain is respectfully traversed. A reconsideration for allowance of these claims is respectfully requested of the Examiner.

Based on the foregoing, the Applicants respectfully submit that all of the pending claims, i.e. claims 1-15, are now in condition for allowance. Such favorable action by the Examiner at an early date is respectfully solicited.

In the event that the present invention is not in a condition for allowance for any other reasons, the Examiner is respectfully invited to call the Applicants' representative at his Bloomfield Hills, Michigan office at (248) 540-4040 such that necessary action may be taken to place the application in a condition for allowance.

Respectfully submitted,

Tung & Associates



Randy W. Tung
Reg. No. 31,311
Telephone: (248) 540-4040

RWT\kd